

# CEMENT AND LIME

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VOL. XXX. No. 4

JULY, 1957

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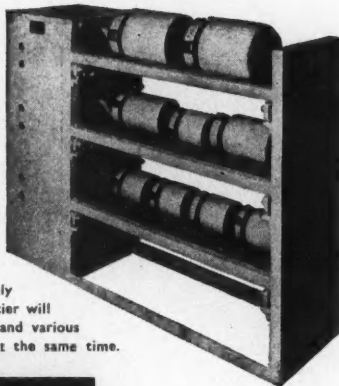
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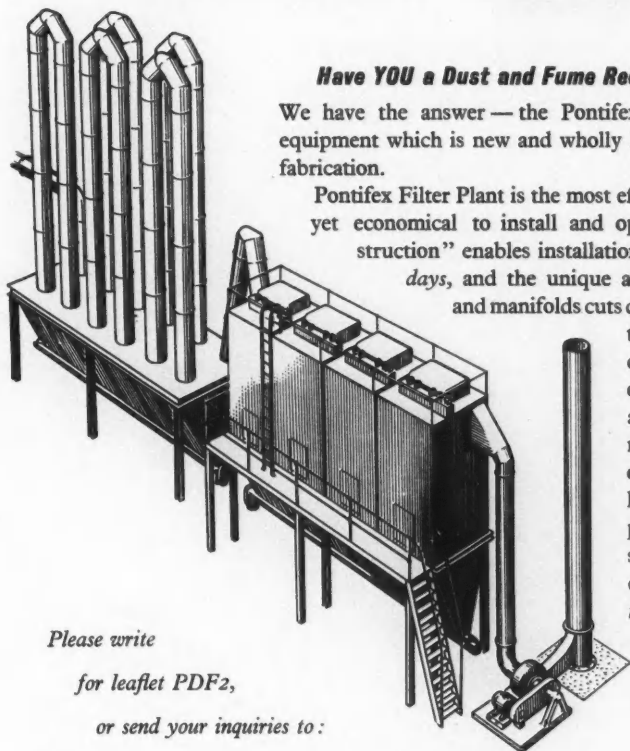


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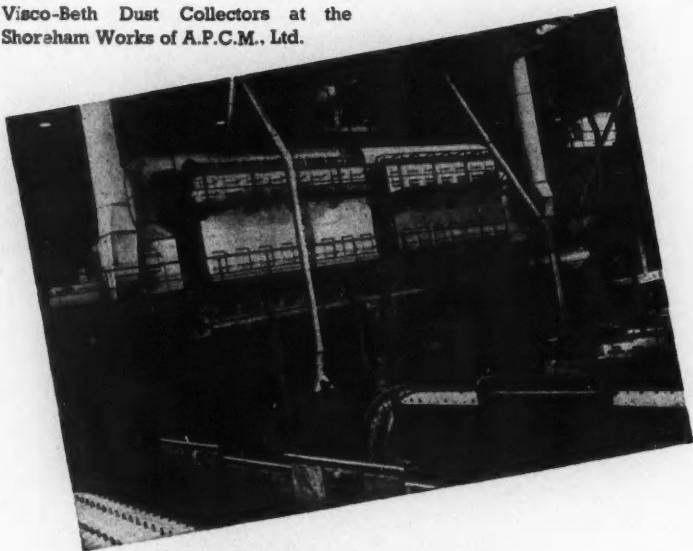


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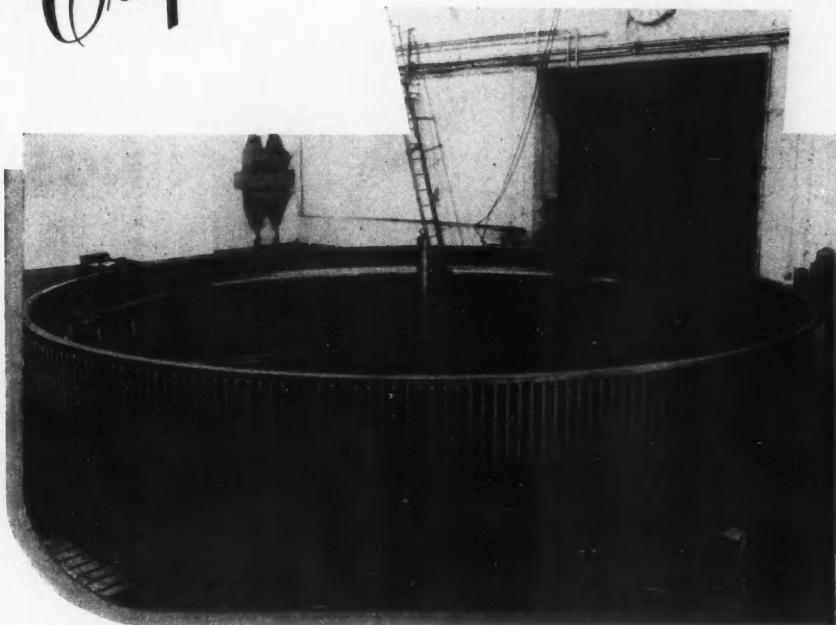
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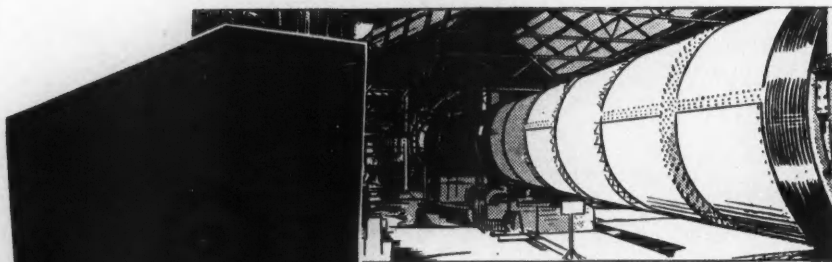
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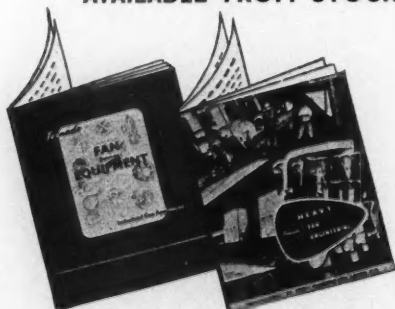
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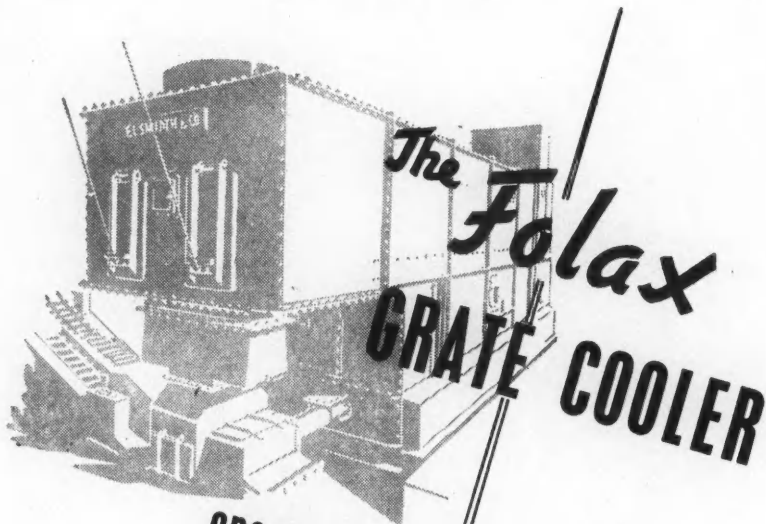
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VOLUME XXX. NUMBER 4.

JULY, 1957

## Cements for Massive Concrete Structures.

A PUBLICATION\* compiled by Professor M. Roš and issued recently on behalf of the Swiss Cement, Lime and Gypsum Manufacturers' Association gives a survey of the materials and methods of construction used in the building of large dams in Europe during the past five years. The publication of this volume of 150 pages coincides with the 75th anniversary of the founding of the Association. The experience gained in Switzerland and elsewhere in the construction of massive concrete structures, and particularly in the choice of cement and the methods of placing the concrete, is of wide interest, and in the following are given the salient points discussed and the recommendations made.

In his opening remarks the author states that there is no generally satisfactory solution to the problem of concreting massive structures, from the points of view either of deciding on the most suitable cement or the method of placing the concrete. Three types of hydraulic binders based on ordinary Portland cement are considered by the author to be the most suitable now available.

(1) Ordinary Portland cement as specified in the 1953 edition of the Swiss standard but with a tricalcium silicate ( $3\text{CaO}.\text{SiO}_2$ ) content of 50 per cent. or less, and a tricalcium aluminate ( $3\text{CaO}.\text{Al}_2\text{O}_3$ ) content of not more than 10 per cent. The cement is ground to about 7 per cent. residue on a sieve with 4,900 apertures per square centimetre and should have a surface area of 2750 sq. cm. per gramme as determined by the Blaine method.

(2) Ordinary Portland cement according to the 1953 Swiss standard but containing an air-entraining agent or a chemical with a plasticising action as well as a small tendency to entrain air.

(3) Ordinary Portland cement according to the 1953 Swiss standard with the addition of slag of known chemical composition, and ground to a surface area (Blaine) of 3,500 to 4,500 sq. cm. per gramme.

With these cements the compressive and tensile strengths, workability, per-

meability, resistance to frost and changes of temperature, and resistance to chemical attack were all satisfactory. On the other hand, no simple and effective way was found to reduce the heat of hydration of cement to a level that would prevent completely uneven temperature gradients in large masses of concrete, with the consequent development of internal stresses, shrinkage, and cracking.

For uniformity and reliability under practical conditions, type (1) cement is considered to be the best. This conclusion is arrived at as a result of experience of many years under a variety of conditions and applications. Concrete made with this cement can be placed at the rate of about 10,000 cu. yd. per 24 hours and has strengths of 5,000 lb. per square inch at 28 days and about 5,700 lb. per square inch at 90 days. As a result of a reduction in the tricalcium silicate and tricalcium aluminate contents there is a reduction in its normal heat of hydration (see Table I) and shrinkage (Table II).

Among the advantages of type (2) cement the author mentions increased plasticity and workability of concrete, considerable increase in impermeability, increase in compressive and tensile strengths, improvement in resistance to frost, a slightly lower heat of hydration and tendency to cracking (although this depends to some extent on the type of air-entraining agent used), and economy in the use of cement.

Type (3) cement was of two kinds. In one the proportion of slag was between 30 and 85 per cent., and in the other it was less than 30 per cent. None of these cements is suitable for massive structures in the proportions of 250 lb. to 500 lb. of cement per cubic yard of concrete.

As regards concrete mixtures and the method of placing the concrete in large dams, the author emphasises that the quality of the cement and aggregate should be as uniform as possible; the concrete must be well compacted to enhance its resistance to moisture, frost, and changes of temperature; the heat of hydration should be as low as possible (in some cases it may be advisable to use artificial cooling while the concrete is hardening).

Air-entraining agents ensure better dispersion of the cement, with consequent reduction in the amount of gauging water required, without reduction of work-

TABLE I.—Heat of hydration of cements used for dams in Switzerland (in cal. per kg). Test results obtained by heat of solution method.

TYPE OF CEMENT	AGE IN DAYS							
	7		28		90		570	
	PROCESS		PROCESS		PROCESS		PROCESS	
	DRY	WET	DRY	WET	DRY	WET	DRY	WET
Ordinary Portland	71.0	—	79.5	—	85.1	—	91.2	—
Portland: slag (70:30)	66.9	64.0	75.6	72.5	80.9	75.4	86.9	83.9
Portland: slag (80:20)	61.0	53.6	70.1	67.4	74.4	70.1	79.6	73.3
Portland: slag (90:10)	50.9	40.0	61.4	49.5	66.8	58.6	71.7	63.6

TABLE II.—Shrinkage of Swiss cements used in massive concrete structures. (Tests on prisms 20 cm. by 20 cm. by 60 cm. containing 390 lb. of cement per cubic yard of concrete; maximum size of aggregate 2½ in.)

TYPE OF CEMENT	7 DAYS		28 DAYS		90 DAYS	
	CURING TIME		SHRINKAGE (PER CENT.)		SHRINKAGE (PER CENT.)	
	RELATIVE HUMIDITY	RELATIVE HUMIDITY	RELATIVE HUMIDITY	RELATIVE HUMIDITY	RELATIVE HUMIDITY	RELATIVE HUMIDITY
	30	70	30	70	30	70
	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.
Ordinary Portland	0.05	0.1	0.057	0.194	0.052	0.40
Portland: slag (70:30)	0.1	0.1	0.057	0.287	0.003	0.45
Portland: slag (90:10)	0.1	0.1	—	0.28	—	0.44

ability, especially when crushed sand or silica aggregate is used (the use of air-entraining agents was found also to reduce the time of construction). Laboratory tests are not always a reliable guide to the behaviour of concrete, and should always be verified by tests on the site.

Portland blastfurnace cement has advantages only if the properties and the mineralogical composition of the slag are uniform.

In the author's opinion the modified standard Portland cement No. (I) will remain for a long time the best for massive concrete structures. Experience shows that the most suitable maximum size of aggregate is  $4\frac{1}{4}$  in. Natural quartz (silica) is preferable, but mixtures of natural (round grained) and crushed quartz are generally used. Washed natural sand is recommended. The fine sand should be separated into sizes of 0.1 mm. to 1 mm. and 1 mm. to 3 mm.; sand finer than 0.1 mm. should not be used. The use of aggregate larger than  $4\frac{1}{4}$  in. is not recommended because of the difficulty of ensuring a homogeneous structure.

---

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We have received the following from Delo (Engineers), Ltd., of Borough High Street, London, S.E.1.

Fig. 3 on page 34 of your number for May 1957 shows a Loesche kiln with a Spohn grate. The Spohn grate, which is exclusive to the Loesche kiln, is the latest patented improvement to the Loesche vertical kiln, of which the development commenced more than forty years ago by the acquisition by Curt von Grueber (the pre-war name of the Loesche organisation) of the patent on the rotary grate. This patent has now expired, and makers of vertical kilns in addition to Messrs. Loesche now embody this design. As, however, the only manufacturer whose name you mention is Messrs. L. de Roll, and that, in such proximity (on page 35) to the illustration and in such context as to suggest that Messrs. L. de Roll can supply vertical kilns with Spohn grates, we shall be grateful if you will print a suitable correction in your next issue.

---

### Cement Works Extension in Pakistan.

It is proposed to increase from 400 tons a day to 800 tons a day the capacity of the Government cement works at Hyderabad.

### Production of Cement in Argentina.

The production of cement in Argentina in the year 1956 was 1,966,000 tons. During the year 50,000 tons of cement were imported compared with 219,000 tons in the previous year. Domestic consumption increased by 8 per cent.

### **The Cement Industry in India.**

The Government of India has issued licences for the construction of the following new Portland cement works and extensions of existing works. The name of the company to whom the licence has been granted is given first, followed by the site of the proposed works or extensions and the annual capacity in tons.

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Enquiries relating to these proposals should be addressed to the Export Services Branch, Board of Trade, Room 732, Lacon House, Theobalds Road, London, W.C.1. (Reference ESB/12438/57.)

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### **Production of Cement in Dominica.**

The production of cement in the Dominican Republic in the year 1956 was 261,172 tons, of which 75,310 tons were exported.

### **New Cement Works in Indonesia.**

A cement works, with a capacity of 250,000 tons a year, started production at Gresik, Indonesia, in May last.



## Determination of Alkali Content of Portland Cement.

IN a recent number of the Bulletin of the American Society for Testing Materials, Mr. O. A. Ellingson, Mr. J. L. Gillam, and Mr. J. E. Kopanda describe tests on various methods of extracting alkalis from Portland cement.

Three types of cement were used. Type A consisted of grey cements in which the total alkalis ( $K_2O + Na_2O$ ) ranged from 0.24 to 1.05 per cent.; type B, white cements in which the total alkalis varied between 0.13 and 0.33 per cent.; type C, grey cements in which the total alkalis ranged between 0.27 and 0.98 per cent. The methods used were as follows.

(1) A.S.T.M. Method C 114-53 (the water-soluble alkali method except that a 50-g. sample was used in all cases instead of varying the size of the sample between 25 g. and 150 g.).

(2) The same as (1) with a 50-g. sample in the steps of obtaining the filtrate. The flame photometric method of A.S.T.M. Method C 228-49 T was used in determining the  $K_2O$  and  $Na_2O$  in the filtrate after adjusting the calcium chloride content of the acidified filtrate. Previous studies had shown that the concentration of  $CaO$  in filtrates from Method C 114-53 ranged between 0.14 and 0.18 g. per 100 ml. Accordingly the filtrate was acidified with 10 ml. of concentrated  $HCl$  and made up to 500 ml. Then 50 ml. plus 8.5 ml. of the stock calcium chloride solution of Method C 228-49 T were made up to 100 ml. and analysed for  $K_2O$  and  $Na_2O$ . The results of these determinations are converted to  $Na_2O$ , as determined in method (1), by the formula: Per cent.  $Na_2O = \text{per cent. } K_2O \times 0.807 + \text{per cent. } Na_2O$ , in which 0.807 is 1.849 (factor converting  $K_2O$  to  $K_2SO_4$ )  $\times$  0.4364 (factor converting  $Na_2SO_4$  to  $Na_2O$ ). For calculation purposes, in A.S.T.M. Method C 114-53 the  $K_2SO_4$  is considered as  $Na_2SO_4$ .

(3) A slurry of 25 g. of cement and 250 ml. of water was shaken continuously at room temperature for ten minutes and filtered on a Buechner funnel until dry. The alkalis were then determined by the flame photometer on samples of 50 ml. of filtrate acidified with 5 ml. of concentrated  $HCl$  to which 8.5 ml. of stock calcium chloride solution were added and the solution made up to 100 ml. The results were calculated to  $Na_2O$  as in (2).

(4) A slurry of 75 g. of cement and 250 ml. of water was shaken for 90 minutes at room temperature. The remainder of this method was identical with the procedure of handling and analysing the filtrate in method 3.

(5) Same as (1) except that the size of the sample was varied as specified in A.S.T.M. Method C 114-53.

(6) Same as (2) except that the size of the sample was varied as specified in A.S.T.M. Method C 114-53.

The results by the first three methods for the group A cements show that the results obtained by method 2, in which the individual alkalis were determined with the flame photometer and calculated to equivalent  $Na_2O$ , agree very well

with the values for  $\text{Na}_2\text{O}$  obtained by A.S.T.M. Method C 114-53 as modified in method 1. Because of this good agreement and because the operations of method 2 are much simpler and quicker, no further work was done with method 1. In general, the results with method (3) were in good agreement with those obtained in (1) and (2). However, method (1) is not identical with Method C 114-53 in that a 50-g. sample was used with all cements instead of the variable-size sample called for in Method C 114-53. Also, a 50-g. sample was used with all cements in (2). It was decided, therefore, to make additional tests in which methods (1) and (2) were changed to correspond with Method C 114-53 with respect to the size of the sample, and (3) was modified by changing the size of the sample from 25 to 75 g. and the shaking period from ten to 90 minutes. This is method (4) and the modifications of methods (1) and (2) are (5) and (6) respectively.

The cements of group B were analysed by methods (3), (4) and (6). There was somewhat better agreement between the results by methods (3) and (6) than by (4) and (6). The cements of group C were analysed by methods (3), (4), (5) and (6). Methods (5) and (6) are identical except for the methods of determining the alkali content of the extracts. The greatest variation between the results by these two methods is 0.03 per cent. equivalent  $\text{Na}_2\text{O}$  content. This is also the greatest variation between the results by the four methods. It appears that any of methods (3), (4) or (6) could be substituted for (5) (C 114). Method (3) is preferred because of the short shaking period.

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### The Cement Industry in Spain.

Cementos y Cales Freixa S.A. (Avenida José Antonio 628, Barcelona) is to expand its factory at Los Monjos, Barcelona, at a cost of 18,500,000 pesetas. Permission has been sought to install a Portland cement factory at Yanguas, Segovia, with a capacity of 60,000 tons per year. A Portland cement factory is to be built at La Magdalena, Castellón, at a cost of 193,300,000 pesetas. Central de Edificaciones, S.A. (a new concern) proposes to build a cement factory at Ribas de Jarama, Madrid, at a cost of 221,000,000 pesetas. A cement works is to be erected at Meco (Madrid) at a cost of 63,500,000 pesetas, and another at Pedrera, Seville, at a cost of 165,000,000 pesetas. The plant for all these new works is to be imported.

A cement factory which is said to be one of the most modern in Europe will shortly be in production for Ferroland, S.A., at Sagunto, with an annual capacity of 120,000 tons of Portland cement and 60,000 tons of special cement.

The production of cement in Spain in the year 1956 was 4,000,000 tons, an increase of 6,000 tons compared with the previous year.

### Production of Cement in the U.S.S.R.

In the year 1956 the production of cement in the U.S.S.R. was 24,900,000 tons; this was an increase of 11 per cent. on the previous year.

## Physico-chemical Problems in the Production of Hydrated Lime.

IN "Zement-Kalk-Gips" for June 1956, A. Backman describes in physico-chemical terms the reaction phases of the slaking of lime and the subsequent properties of the product as a building material. The article is mainly concerned with non-hydraulic limes slaked by the dry process and is summarised below.

Dry slaking produces a recognisable pattern of reaction. The process uses a proportion of water stoichiometrically equivalent to twice the amount of free lime. The water is taken up with a certain delay, forming a homogeneous solid mass. This solid mass begins to loosen with vigorous evolution of water vapour, forming a seething powdery product. When the evolution of vapour subsides, the powder loses mobility and becomes compact.

Different types of lime show variations in sharpness of definition between these phases, but the phases can still be recognised. Quick-slaking types have an almost instantaneous temperature rise, and development of vapour occurs simultaneously with the uptake of water. Sluggish types develop vapour gradually, and the transformation from bubbling aerosol to compact powder is indistinct.

Although individual grains have varying speeds of reaction, general phases can be distinguished as follows: (1) Uptake of water; (2) Formation of a metastable intermediate product  $\text{CaO} \cdot 2\text{H}_2\text{O}$ ; (3) Rearrangement reaction;  $\text{CaO} \cdot 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2\text{O} + 15.5 \text{ kcal.}$ ; (4) Flocculation and final agglomeration.

The first two phases appear to occur at the same time in a supersaturated system. The system then changes to a homogeneous slip, which later hardens to the solid intermediate product. With pressure slaking, when the pressure has risen 0.5 or 0.6 atmospheres, the stiff solid mass becomes semi-plastic. In the continuous process this point is registered by a reduction in the load on the stirring motors.

It is possible that the addition product is a kind of oxide hydrate formed by co-ordinate linking of water, similar to that formed by magnesium oxide; studies by the author using supercooled components and determining heats of reaction indicate that it may be  $\text{Ca}(\text{OH})_2 \cdot \text{H}_2\text{O}$ , with retarded release of energy. The reaction may proceed from addition product to monohydrate (reported in the literature as a very unstable form) and then with evolution of vapour to the hydroxide. Such a scheme conforms to established conceptions in which initial and final states are separated by an energy threshold, which must be surmounted by the energy of activation before the process can occur with release of energy.

The last phase of the slaking process is flocculation due to the dipole character of calcium hydroxide, causing the crystallites to coalesce to a certain equilibrium weight of floc. Under certain conditions a very dense form of agglomeration can occur, accompanied by evolution of heat which can be detected in an incorrectly-regulated slaking process producing an overburnt lime. A correctly-burnt lime remains as an energy-rich system. Much of the behaviour of lime has a similarity

with Kautsky's idea of permutoids, that is structures in which the constituent groups can react quantitatively with foreign molecules.

In judging the quality of quicklime, the usual criterion, that is the content of active  $\text{CaO}$ , has its limitations. Analytically determined  $\text{CaO}$  may not correspond to that actually available for slaking; physical form and reaction energy are important. Rhombohedral calcite is converted on burning into a cubic oxide of less volume, but the lime maintains an almost unchanged external and structural form, and this is more clearly evident the more mildly the lime is burnt. This pseudo-crystalline lattice (which is destroyed by over-burning) contains a definite amount of labile energy.

It is known that lime exposed to the electric field of a storm tends to crumble and lose activity. The author measured the slaking energy of a mildly-burnt lime before and after subjecting it to an electrostatic field, and showed a loss of 90 per cent of the theoretical amount of energy (2.57 kcal. per molecule). Mechanical reduction of the size of the lime also releases part of this energy in proportion to the extent of subdivision; a slow loss also occurs during storage, even in a closed container.

The greater the residual energy in the lime, the greater is the quantity of heat developed in the slaking reaction, which accounts for differences in the values given by different authors. When some of the residual energy in the lime remains behind in the hydroxide, the hydroxide possesses a floc structure favourable to plasticity of the mortar. If a glass rod be electrically charged by rubbing and a sample of lime stirred with it, the lime takes up all the charge of the rod. Only after several repetitions is a residual charge in the rod shown by an electroscope, when the lime is finally saturated with electricity. If the electrically-charged lime is dry slaked, the resulting product shows a looser floc structure than does uncharged lime.

Although the content and size of subdivision of impurities play a large part in determining the character of a lime, these do not alone explain various individualities, which also go beyond mere differences in methods of burning or slaking. In cases where one crystal system changes into another, remains of the previous lattice persist as "inheritance factors" in the new crystal structure. The formation of calcium carbonate in nature always occurs from bicarbonate, whether the crystallisation results inorganically or is caused by living organisms. The carbonate is deposited from bicarbonate solution as calcite at temperatures under 25 deg.C., as aragonite at 100 deg.C., and in the mixed crystalline form at intermediate temperatures. Its form can also be influenced by primitive organisms. Calcite represents the most stable crystal form, so that a recrystallisation to calcite occurs in the course of millions of years; thus lattice flaws originating from aragonite remain behind.

In industrial slaking, the grain-size and distribution and the porosity of the quicklime are important. The water must come into contact with each grain of lime before reaction begins. An ideal burnt lime has the form and volume of calcite with theoretically 54 per cent of pores. This porosity decreases with the degree of overburning. A pure lime needs 64 per cent of water for an ideal slaking reaction,

with two molecules of water per molecule of lime. Porosity falls as impurities increase. Uniform grain size is best. Fines take up an excessive share of water and cause lumps enclosing air, hindering penetration of water; the wetted fines also form isolating layers around the coarser grains.

Salts in the slaking water which increase the heat of reaction ( $\text{CaCl}_2$ ,  $\text{MgCl}_2$ ) cause development of heat in the final agglomeration stage, resulting in poor plasticity. Saturated calcium hydroxide produces a lower heat of slaking than water, corresponding to an energy-rich product, and furnishes a better material in respect of plasticity than pure water under corresponding conditions.

Certain organic groups, notably the aldehyde group, even in very low concentration have a pronounced favourable effect on the plastic properties. This applies only to the younger organogenic limes and not to limestone. Increase in the molecular weight of aldehydes decreases the effect owing to hydrophobic action of the rest of the molecule; formaldehyde has a notable effect with 10 gr. to 30 gr. per ton. Since the aldehyde group forms an unstable hydrate, the water molecule is attached to oxygen, facilitating activation to form the intermediate product. The reaction phases then become more clearly defined.

Wetting agents in the slaking water assist penetration, and some surface active substances have an antistatic effect on the final agglomeration. In the same way that polarised water can cause boiler deposits to precipitate as free slurry instead of a solid scale, it can bring about a much looser floc texture in hydrated lime.

The first requirement of a slaking plant is good mixing. It is well known that local deficiencies in water cause overheating and excessive agglomeration, known as dead-slaking. It is less well-known that a form of dead-slaking can occur with excess water. The product after slaking should not contain more than 0.5 per cent residual moisture. Pressure slaking acts favourably on homogenisation, and one atmosphere produces a velocity of reaction about  $2\frac{1}{2}$  times as great, so that the more sluggish grains react. Discharging should be arranged so that the water-vapour enclosed under pressure in the mass can expand spontaneously to form small loose flocs. There is a technical belief that the unslaked particles, mostly coarse ones, possess a special power to mix intimately with the light slightly-moist hydrate during high temperature post-slaking storage, but under such conditions harmful agglomeration of the flocs is catalysed by the moisture. The content of unslaked lime must not be sufficient to cause blisters in the mortar. Unslaked particles must not exceed 0.5mm; an air-separator will collect the larger particles. A certain amount of slaking in the mortar decreases shrinkage but lowers the binding value.

The minimum strength of mortar occurs at degree of carbonation between 30 and 50 per cent. In this range filling due to crystallisation has not begun although the volume is increasing freely; slaking of residual oxide is now harmful. The best method of controlling the unslaked material is by a combination of calorimetric and briquette tests. The difference between the readily-slaked portion and the total amount unslaked can then be regarded as the potentially dangerous unslaked material. Pressure slaking gives the best results.

The resolving power of an optical microscope is insufficient to show the fine crystalline structure of technical hydrates. With the electron microscope, although the resolving power and magnification are ample, the preparation is modified by the high vacuum and hard rays, and a negative impression has to be used. Much can, however, be learned by a simple examination of the flocs with an optical microscope. A microscope slide is wetted on one side with immersion oil, and the oil dried to give a uniform film. The sample is gently pressed into the film by a spatula so that material of the thickness of one floc sticks to it, and the surplus is removed by light tapping. The preparation can then be examined dry, using immersion oil between the slide-glass and the objective. Single crystallites can be seen in the hexagonal structure as well as the strong dipole growth of the crystallites.

An extremely finely divided sample of calcium hydrate was examined in suspension in immersion oil on a slide with a cover-glass on top. As soon as the cover-glass was applied, the original floc structure was broken up and the crystallites were entirely homogeneously suspended in oil. After a few minutes a tendency towards the formation of new floc set in, but with orientation and in large units. After a few hours the flocs were still larger, the edges began to form an hexagonal pattern, and finally the agglomerates assumed the form of hexagonal platelets, in which the contours of separate crystals were less and less distinct. A light pressure on the cover-glass again subdivided the crystallites but if the resulting suspension was left undisturbed the orientated flocculation started again. After a few days the crystallites had grown together in their new orientation to a single crystal which could no longer be squeezed back into a suspension. It is clear that growth is stimulated by well-formed hexagonal edges so that hydrated lime should be in a form that will retard edge-growth. This gives new meaning to the phenomenon of "dead-slaking" and ageing on storage.

The size and distribution of flocs can be measured simply and reliably by the Andreasen method, using ethyl alcohol as dispersion liquid. Comparing results obtained with an air separator to its lower limit of  $7.5\mu$ , the author obtained good agreement and concluded that the equilibrium of flocs in alcohol corresponds very well with the equilibrium of lime flocs in air. Lime solution causes very large flocs of 80 to  $100\mu$  to form. Flocculation and velocity of settling should be applied with caution as criteria of the quality of lime, in spite of certain relationships to the plastic properties. Any method used to determine active surface must be capable of registering surfaces at least up to 2.5 square metres per gramme.

In rheological behaviour, lime suspension has a plastic limit and is thixotropic, thus exhibiting semi-colloidal properties. With high shear velocity, dilatance appears as evidence that internal particle interference is greater than the pseudo-colloidal behaviour, due to disruption of the aqueous layers surrounding the particles. These properties are reflected as workability characteristics and vary considerably among different types of lime.



Side-valency forces can cause a molecule of  $\text{Ca(OH)}_2$  to bring up to eight molecules of water within its sphere of influence. The alkaline earth metals barium and strontium, next to calcium in the periodic table, form hydroxides crystallising with one and eight molecules of water. Both the basic and crystalloid characters increase with atomic weight in the group (beryllium hydroxide is a pure colloid). The side-valency forces which form crystalline hydrates in the cases of strontium and barium are not strong enough in calcium hydroxide to form a new lattice, and can attract only a corresponding number of molecules into a liquid layer.

The author has shown that the dehydration curve of calcium hydroxide paste shows a kink at the stoichiometric composition  $\text{Ca(OH)}_2 \cdot 8\text{H}_2\text{O}$  analogous to that caused by strontium hydroxide octahydrate, but less clearly defined. Different limes give different time/temperature curves for slow dewatering. The ideal curve shows inflections at the composition  $\text{Ca(OH)}_2 \cdot 4\text{H}_2\text{O}$ , corresponding to the composition when trowelling the surface, and also at  $\text{Ca(OH)}_2 \cdot \frac{1}{2}\text{H}_2\text{O}$ , which is the optimum water content in the carbonation phase. The four water molecules first removed require only a third of the total evaporation time.

Strongly thixotropic limes, on reaching a temperature of 94 deg. C. have a momentary rise to about 99.5 deg. C. due to a loss of energy content. A sharp fall in temperature occurs at the composition  $\text{Ca(OH)}_2 \cdot \frac{1}{2}\text{H}_2\text{O}$ . Types having maximum plasticity also produce maximum strength, and all the factors that facilitate the formation of layers of water around the crystallites improve the plastic properties and adhesiveness, but lengthen the time before trowel finishing. Limes that attract water insufficiently are subject to "bleeding."

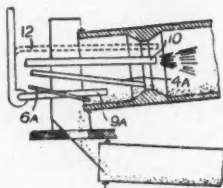
Limes vary in their sensitivity to lack of fines in sand. Among the least sensitive in this respect are those containing a certain quantity of finely-divided quartz grains. The effect of sands lacking in fines can be compensated for even if the quartz content is far smaller than the missing fines. This is probably due to the powerful surface-negative effect of finely-divided quartz.

Foaming agents provide an apparent plasticity without stability of form and without the cohesive and adhesive forces of truly plastic limes. Enough air (8 to 10 per cent.) can be entrained by a good mortar-mixer without an agent. Hydraulic properties act contrary to plasticity, so that the extent to which they are to be exploited must be decided. The hydraulically-active lime compounds are stable above 900 deg. C. and occur at lower temperatures only in the so-called frozen state. The inactive modifications are stable at lower temperatures. Rapid cooling through 1,000 to 700 deg. C. retains the hydraulic character and also keeps the lime crystals small.

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### Making White Cement.

Patent Application No. 742,559 in the name of Messrs. F. L. Smidth & Co. A.G., relates to the manufacture of white Portland cement. In this process, white cement is made by rapidly cooling clinker under non-oxidizing conditions, removing the cooling fluid by suction independently of the draught through the kiln and so preventing it flowing into the combustion



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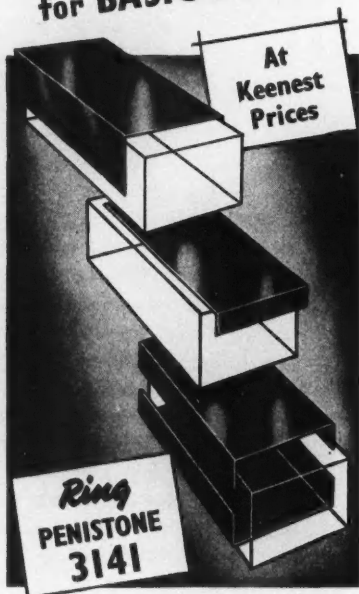
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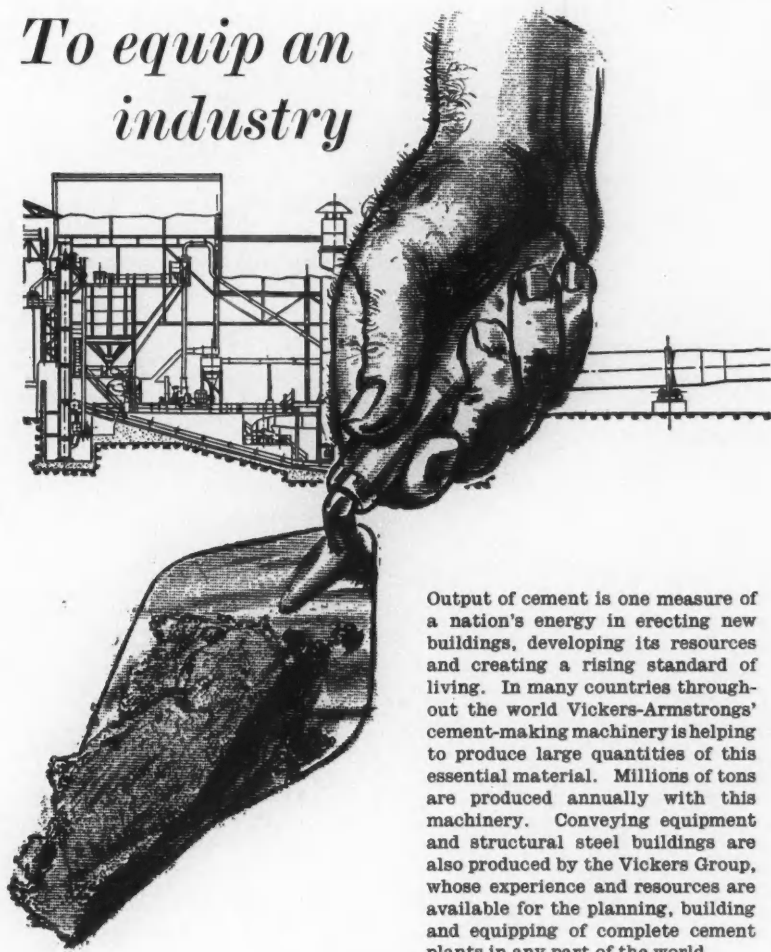
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### **The Cement Industry in Canada.**

The following report has been received from H.M. Trade Commissioner in Canada.

Although the production of cement in Canada increased from 4,200,000 tons in the year 1955 to 4,933,000 tons in 1956, imports increased by about one-third to more than 500,000 tons.

During 1956 and the early months of 1957 nearly 2,333,000 tons were added to the capacity of the industry. Early in 1956 the Canada Cement Co., Ltd., increased the capacity of its Montreal East plant by 250,000 tons annually, and towards the end of the year the works at Woodstock, Ontario, with a capacity of 250,000 tons a year, came into operation; the capacity of this works has since been doubled. In November the St. Lawrence Cement Co. began production at its new works at Clarkson, Ontario, with a capacity of 250,000 tons a year, and this is to be doubled in 1957. At the end of 1956, St. Mary's Cement Co. started a works at St. Mary's, Ontario, with a capacity of 166,000 tons a year. At Edmonton, the capacity of the plant of the Inland Cement Co., which started at a rate of about 166,000 tons a year early in 1956, was doubled by the end of the year. At Regina, the Saskatchewan Cement Corporation started production at a works with a capacity of 141,000 tons a year in 1956. The Lafarge Cement Co. (North America), Ltd., has placed contracts for the construction of a works near Vancouver with a capacity of 216,000 tons a year and this is to be in produc-

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tion early in 1958. Other projects for extensions include the Lake Ontario Portland Cement Company's works of 300,000 tons capacity at Picton, Ontario, which is to be in operation late in 1957; additional capacity at the works of the British Columbia Cement Co.; and an additional capacity of 133,000 tons at the works of the Maritime Cement Co., at Havelock, New Brunswick.

The capacity of the Canadian cement industry is expected to be adequate for all requirements by the end of 1957.

#### **Production of Cement in Mexico.**

The production of cement in the year 1956 was 2,276,700 metric tons, compared with 2,085,700 metric tons in 1955 and 878,800 metric tons in 1946. New works are being built by Cementos California, S.A., at Ensenada, and by Cementos Atoyac, S.A., at Puebla. New kilns with a total capacity of 550,000 tons a year are to be installed at existing works by the end of the year 1958.

#### **Production of Cement in Angola.**

In the year 1956 the production of cement in Angola (Portuguese West Africa) was 87,261 tons, compared with 70,323 tons in 1955 and 42,162 tons in 1954.

#### **Proposed New Cement Works in Colombia.**

It is reported that a cement works is to be built at Bolivar with a capacity of 2,500 tons a day, and one at Huila with a capacity of 500 tons a day.

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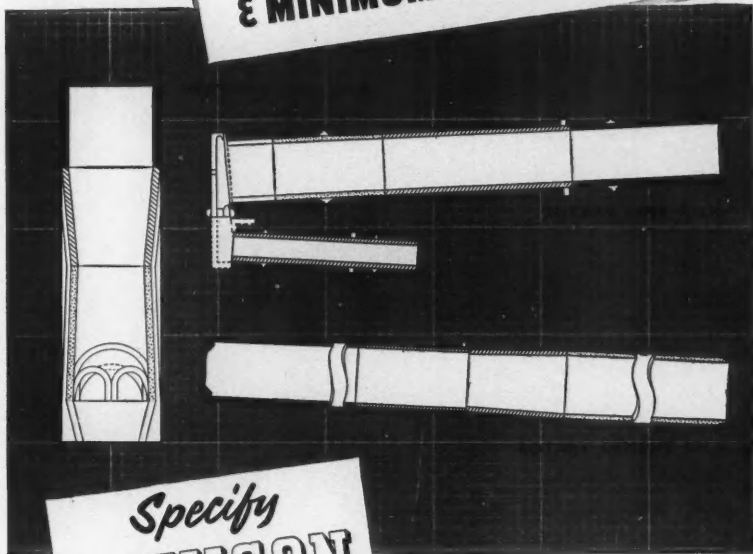
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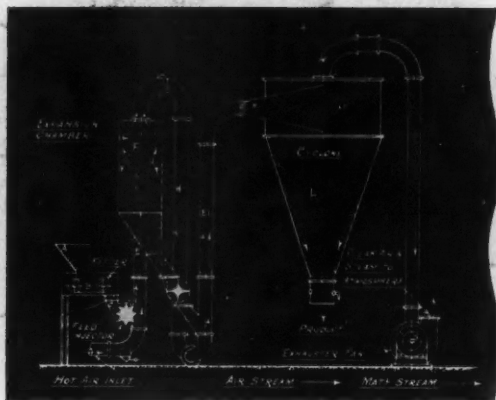
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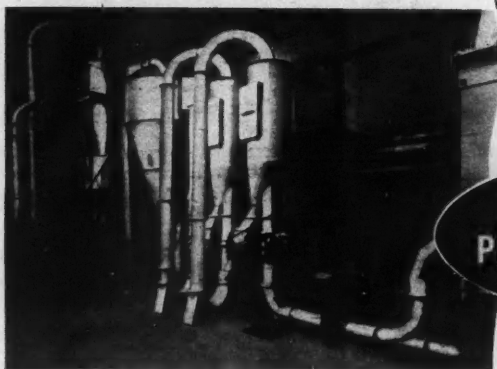


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